4. Lessons Learned in Introducing MBSE: 2009 to 2012

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Abstract

An overview of the lessons that are emerging from recent efforts to employ MBSE in the development of large complex projects in both the defence and civilian sectors. A broad interpretation of MBSE will be taken to encompass tool systems that embody the spirit of MBSE, if not the specific modern practice arising from the OMG/INCOSE sources. The paper will address findings on lessons learned with respect to process development, cultural resistance, management perception and training methods and needs.

Presenter Biography

A. Peter Campbell returned to Australia from 22 years in the US in late 2000. He worked on three year contract (2004-07) for CSIRO Complex Systems Science Initiative to introduce complex system simulation tools for agricultural landscape planning and critical infrastructure analysis. In May 2004, Peter joined the Systems Engineering and Evaluation Centre (SEEC) at the University of South Australia as Professor of Systems Modelling and Simulation, working on the application of complex adaptive system simulation technology to large scale system integration projects at UniSA. Recent research includes architecture design for model based systems engineering applications to support evolvable systems integration management and the development of software agents to replace humans in the loop in defence T&E environments.

Now in Defence and Systems Institute (DASI) at UniSA Peter has the responsibility for business development of modelling and simulation, particularly in the defence area. October 2010 joined University of Wollongong as Professor of Infrastructure Modelling in the SMART Infrastructure Facility while continuing at UniSA. Work is in the area of the application of ABM and MBSE to the improvement of the management of large infrastructure development projects, with a specific project to develop an ABM of the interaction between transportation needs and changing demographics in metropolitan Sydney.

Prior to 2000 Peter worked at Argonne National Laboratory in US for 15 years where he was involved in the development of advanced agent based modeling methods with application to decision support tools for defence and industry applications. Project lead and designer for ABM tools for energy supply, drug interdiction, hospital work flow, logistics operations and a range of defence applications

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14. ABSTRACT
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Presentation

Lessons Learned in Introducing MBSE -2009 to 2012

By

A. P. Campbell

UniSA, Nov. 2012

Introduction

- This presentation is based on a survey done for DSITA in late 2012
- Several themes became apparent
  - Huge amount of work going on globally at the SOS level and organisational modelling
  - Further tool development, and especially the production of domain specific templates and profiles make things a bit easier
  - Still a dearth of specific ROI numbers

Older Lessons - 1

- Organisational cultural change is generally needed – so there needs to be specific effort made to do this
- Upper management support is essential – upfront costs, for tools, training, infrastructure, schedule
- There remains a dearth of expertise, so early work needs to be planned for this constraint
- Frequent – daily – interactions are needed to ensure processes remain coherent at the beginning of project
- The models must continue to evolve – model maintenance is often neglected because it is seen as expensive – also requires some organisational change

Some Sources -1

- Some of the important sources emphasising the need for addressing cultural change and obtaining management support:
  - Rolls-Royce
  - NASA/JPL
  - UK MOD
  - EELT
  - Crescendo – EADS and ~ 50 others
  - NDIA !

Older Lessons - 2

- Real examples are needed to convince others of the benefits
- It is hard to do – just do it, but on a small scale first
- Some of the benefits are:
  - Reduced time to completion
  - Earlier risk identification
  - Reduced rework
  - Better prospects for re-use

Older Lessons - 3

- Benefits (continued)
  - Enhanced interoperability
  - Captures lifecycle information for future upgrades
  - Improved reliability
  - Models have more to contribute than just supplying quantitative analysis – they improve capture and description of design and are powerful first steps, immediately improve communication and understanding ("The benefits of this would be difficult to overstate" JPL)

Newer Lessons - 1

- There are psychological reasons why it is hard as well as cultural ones. ("The human mind wants positive progress. In engineering this is seen in the tendency to prioritize developing solutions, and working the first feasible idea - an illusion of progress. We must recognise that this is natural human behaviour, and take explicit steps to avoid it." Beasley 2012)
- Organisational structure change to remove stove piped responsibilities
- Leverage learning with synergistic work – related to "just do it"?

Some Sources -2

- Correct structuring of projects is necessary to ensure maximum benefit for use of MBSE
  - NDIA
  - EELT
  - Aster S.p.A
  - SOS – several of the presentations at TTCP JSA TP4, 2012

Newer Lessons - 2

- Suggested team organisation for a large project – 3 tiers: (From JPL Europa study)
  - Small core of ~ 6 modellers – but don't isolate it
  - Larger group of ~ 20 modelling savvy engineers – where the top level expertise resides, such as the system architect
  - The rest of the project personnel
- Pay attention to the level of detail that modelling is taken to – duality OK in large project as long as consistent at top level
- Useful for supporting virtual integration

Newer Lessons - 3

- Helps to overcome the human tendency to read what we think text says, rather than what it actually says
- Keep model and analysis separate – enables model re-use on later analyses of different options
- Usefulness of "socialising", managing staff rotation in long running projects, need for total involvement of all team members

Some Sources -3

- NASA/JPL – space networks project
- WSAF
- SOS – several of the presentations at TTCP JSA TP4, 2012
- Renault

Major Program Applications

- CRESCENDO (Realisation system and Intervention system) EADS et al (and VIVACE)
- SWTFS (Submarine Warfare Federated Tactical System) 13% savings in SE work, 25% reduction in capability dev't work and 10% quicker than using DOORS in baseline management
- EELT

Project Level Applications/Studies

- Europa project (JPL, Bayer)
- Gripen (SAAB, Herzog)
- SysML vs Siemens Team Centre (Boeing, Gau)
- A PLM system for auto manufacture (Ciriello)
- Another comparison study (BAE, Wilber)
- MBSE savings (Raytheon, Saunders)
- Manufacturing System design (GIT, Batarseh)
- Requirements for defence systems (ASTER, Petrinca)
- US FAA NextGen

LMCo JSF Modelling

The Lockheed Martin Simulation and Systems Integration

Laboratories Ft. Worth Texas

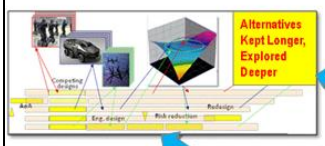
- Not much to do with MBSE as we are talking about it here, but I want to tell you about it anyway –"Virtual to real"
  - 29 Simulation labs for F16, F22, F35, plus a complete system flying in a 737 plus another complete system in an F35 body on special mount on top of one of the buildings
  - Flight Control System, VTL system, Mission system, 6 DoF simulator, even a PC version to introduce FCS system, etc
  - Stove piped until very late 1990s – DOD 5000 series standards required huge amount of work to integrate
  - Would have been much quicker and cheaper if they had been able to use todays tools

Major SOS Research and Programs

- DANSE - Designing for Adaptability and evolutioN in System of systems Engineering – EU FP7
- SAVI – System Architecture Virtual Integration. International effort through the Aerospace Vehicle Systems Institute -2006-2016 (Standard data storage and exchange constructs enable early virtual integration of models distributed across the supply chain. A monolithic solution is not practicable.)
- Architecture framework for the Renault System and Safety data-model
- US DOD Implementations and Initiatives – briefly shown on next 5 slides: ERS, CREATE, AVM, FACT, DISA

MBSA as a Foundation for Engineered Resilient Systems

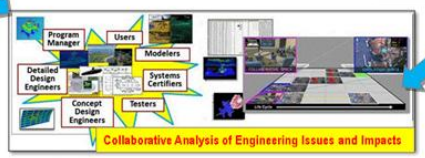
Systems Representation and Modeling
– Physical, logical structure, behavior, interactions, interoperability…



Characterizing Changing Operational Contexts
– Deep understanding of warfighter needs, impacts of alternative designs

Cross-Domain Coupling
– Model interchange & composition across scales, disciplines

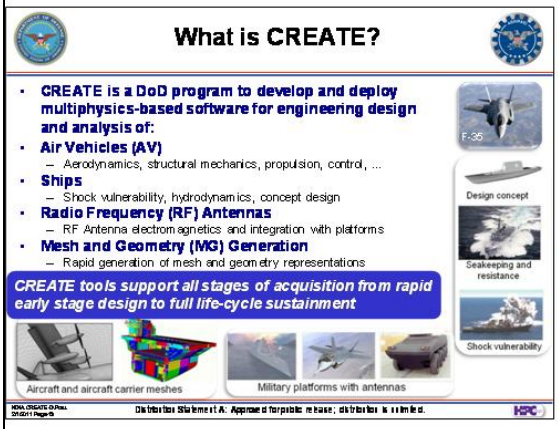
Data-driven Tradespace Exploration and Analysis
– Multi-dimensional generation/evaluation of alternative designs

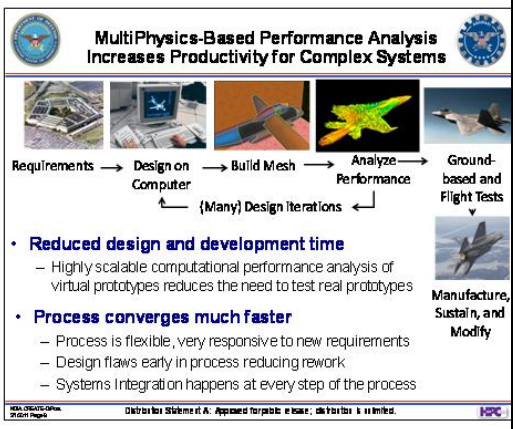


Collaborative Design and Decision Support
– Enabling well-informed, low-overhead discussion, analysis, and assessment among engineers and decision-makers

Computational Research and Engineering Acquisition Tools and Environments (CREATE)

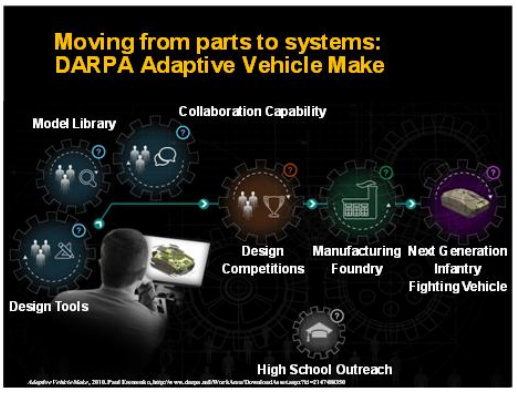
- Enable major improvements in DoD acquisition engineering design and analysis processes, by developing and deploying scalable physics-based computation engineering software products

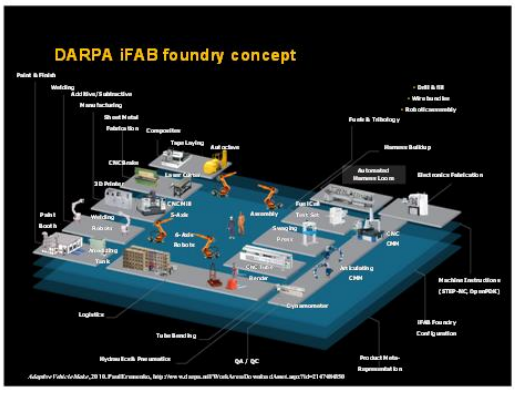




MBE: Adaptive Vehicle Make (AVM)

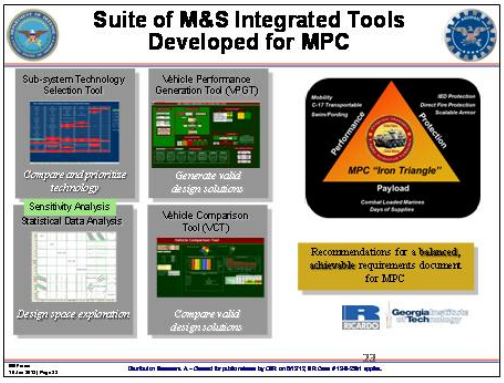
- DARPA program to address the technical problem at the 'seams' – between stages of production, between components, and between organizations. 3 major parts: Shorten development times for complex defense systems; Shift product value chain toward hi-value designs: Democratized design

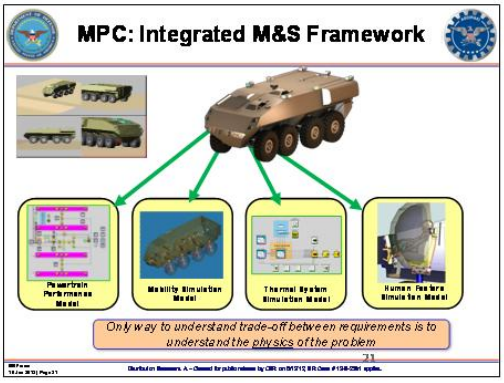




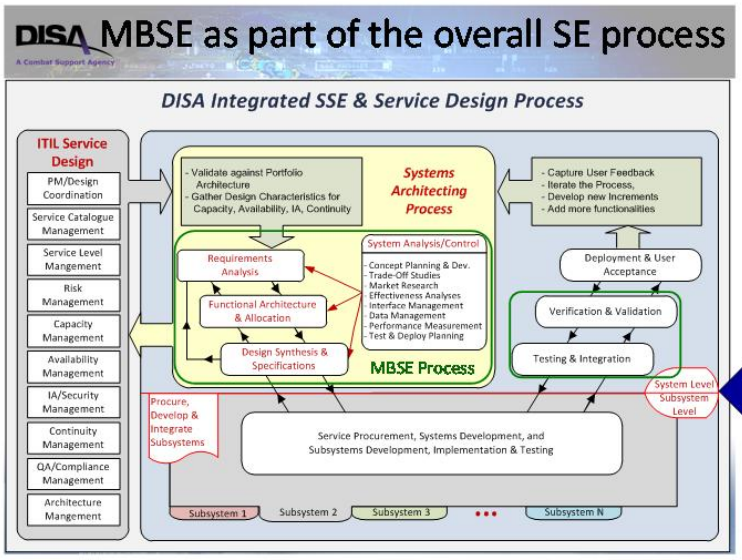
MBE: Framework for Assessing Cost and Technology (FACT)

- A USMC M&S Systems Engineering process enabling rapid trade space and alternative analysis by simultaneously exploring the trade space between cost, schedule, performance and risk





MBSE as Framework for Overall DISA SE Process



- Use as the model and environment to support their role as enterprise engineering for common services in the DoD IT infrastructure
- Provides a common framework ('Systems level') for diverse and distributed ('Sub-systems level') design and engineering activities

Tools

- Kalawsky et al (2012 unpublished) Model based system design and HIL simulation for system verification with model transformation tools to facilitate bi-directional transformation of a Rhapsody model to a Simulink model
- Tool set for developing Aviation Safety-Critical Runtime with Ability to Certify to Do-178B Level A - Atego
- Dassault Catia, Siemens NX – fully integrated PLMs
- OMG Model Interchange Working Group

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